

U.S. Patent Application No. 09/996,505  
Amendment dated October 15, 2003  
Reply to Office Action dated July 16, 2003

**AMENDMENTS TO THE CLAIMS:**

This listing of claims will replace all prior versions, and listings, of claims in the application:

**LISTING OF CLAIMS:**

Claim 1 (currently amended): A sorbent cartridge comprising at least two layers, wherein one of said layers comprises at least sodium zirconium carbonate in said sorbent cartridge.

Claim 2 (currently amended): The sorbent cartridge of claim 1, wherein ~~said sodium zirconium carbonate is present as a layer in said sorbent cartridge~~ wherein one of said layers consists essentially of sodium zirconium carbonate.

Claim 3 (original): The sorbent cartridge of claim 1, further comprising zirconium phosphate.

Claim 4 (original): The sorbent cartridge of claim 3, wherein said zirconium phosphate is present as a layer in said sorbent cartridge.

Claim 5 (original): The sorbent cartridge of claim 3, wherein said zirconium phosphate comprises a  $H^+$  content of from about 1.4 to about 2.0 wt%;

a  $Na^+$  content of from about 4 to about 6 wt%;

a  $ZrO_2$  wt% of from about 34 wt% to about 37 wt%;

a  $PO_4$  wt% of from about 41 wt% to about 43 wt%; and

a  $H_2O$  wt% of from about 14 wt% to about 18 wt%, based on the weight of the zirconium phosphate.

Claim 6 (original): The sorbent cartridge of claim 3, wherein said zirconium phosphate has at least one of the following characteristics:

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a) an adsorption capacity for ammonia of from about 20 mg  $\text{NH}_4\text{-N/gm ZrP}$  to about 45 mg  $\text{NH}_4\text{-N/gm ZrP}$ ;

an adsorption capacity for  $\text{Ca}^{2+}$  of from about 2 mEq  $\text{Ca}^{2+}/\text{gm ZrP}$  to about 7 mEq  $\text{Ca}^{2+}/\text{gm ZrP}$ ;

an adsorption capacity for  $\text{Mg}^{2+}$  of from about 1 mEq  $\text{Mg}^{2+}/\text{gm ZrP}$  to about 5 mEq  $\text{Mg}^{2+}/\text{gm ZrP}$ ; and

an adsorption capacity for toxic heavy metals of from about 3 mEq  $\text{HM/gm ZrP}$  to about 9 mEq  $\text{HM/gm ZrP}$ ;

b) a  $\text{Na}^+$  content of from about 1.8 mEq  $\text{Na}^+/\text{gm ZrP}$  to about 3 mEq  $\text{Na}^+/\text{gm ZrP}$  at a pH of from about 5.5 to about 6;

c) a minimum leachable  $\text{PO}_4^{3-}$  of less than about 0.05 mg  $\text{PO}_4^{3-}/\text{gm ZrP}$ ; or

d) satisfying ANSI/AAMI RD-5-1992 standard on extractable toxic impurities.

Claim 7 (original): The sorbent cartridge of claim 5, wherein said zirconium phosphate has no residual sulfate or chloride.

Claim 8 (original): The sorbent cartridge of claim 5, wherein said zirconium phosphate has less than 0.01% sulfate, chloride, or both.

Claim 9 (original): The sorbent cartridge of claim 3, wherein said zirconium phosphate in  $\text{H}_2\text{O}$  has a pH of from about 6 to about 7.

Claim 10 (original): The sorbent cartridge of claim 3, wherein said zirconium phosphate has an average grain size of from about 30 to about 40 microns.

Claim 11 (currently amended): A sorbent cartridge comprising an alkali metal-Group IV B metal carbonate, wherein said alkali metal-Group IV B metal carbonate is present as a layer in said

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sorbent cartridge.

Claim 12 (canceled)

Claim 13 (original): The sorbent cartridge of claim 11, further comprising a Group IV B metal phosphate.

Claim 14 (original): The sorbent cartridge of claim 1, further comprising alumina, alumina supported urease, granular activated carbon, or combinations thereof.

Claim 15 (original): The sorbent cartridge of claim 14, wherein said alumina, alumina supported urease, and granular activated carbon are each present as separate layers in said sorbent cartridge.

Claim 16 (currently amended): The sorbent cartridge of claim 15, wherein said layers have the following order:

- a) said sodium zirconium carbonate;
- b) a zirconium phosphate;
- c) said alumina;
- d) said alumina supported urease;
- e) said granular activated carbon.

Claim 17 (original): The sorbent cartridge of claim 16, wherein said sorbent cartridge further comprises a first filter pad located above and in contact with said sodium zirconium carbonate, a second filter pad is located between and in contact with said alumina supported urease and said granular activated carbon, and a third filter pad is located beneath and in contact with said granular activated carbon.

Claim 18 (original): The sorbent cartridge of claim 17, further comprising a flow diffuser

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located beneath and in contact with said third filter pad.

Claim 19 (original): The sorbent cartridge of claim 1, wherein said sodium zirconium carbonate comprises from about 2 wt% to about 5 wt%  $\text{Na}^+$ ;  
from about 44 wt% to about 50 wt%  $\text{ZrO}_2$ ;  
from about 12 wt% to about 18 wt%  $\text{CO}_3^{2-}$ ; and  
from about 30 wt% to about 40 wt% LOD, based on the weight of the sodium zirconium carbonate.

Claim 20 (original): The sodium zirconium carbonate of claim 1, wherein said sodium zirconium carbonate satisfies ANSI/AAMI RD-5-1992 standard on extractable toxic impurities.

Claim 21 (original): The sodium zirconium carbonate of claim 1, wherein said sodium zirconium carbonate satisfies at least one of the following characteristics:

a phosphate adsorption having a minimum capacity of from about 30 to about 35  $\text{mg/PO}_4\text{-P/gm SZC}$ ;

a minimum  $\text{HCO}_3^-$  content of from about 2 to about 4  $\text{mEq HCO}_3^-$  per gm SZC;

a leachable  $\text{Na}^+$  content of from about 1.5 to about 2.0  $\text{mEq Na}^+/\text{gm SZC}$ ;

or a pH range of titrated sodium zirconium carbonate of from about 6 to about 7.

Claim 22 (original): The sorbent cartridge of claim 1, further comprising hydrous zirconium oxide.

Claim 23 (original): The sorbent cartridge of claim 22, wherein said hydrous zirconium oxide is in the acetate form.

Claim 24 (original): The sorbent cartridge of claim 23, wherein said sodium zirconium carbonate and said hydrous zirconium oxide are present in a weight ratio of about 1 to 1.

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Claim 25 (original): The sorbent cartridge of claim 23, wherein said sodium zirconium carbonate and said hydrous zirconium oxide are present in a same layer and are blended together.

Claim 26 (original): The sorbent cartridge of claim 1, further comprising zirconium basic carbonate.

Claim 27 (original): The sorbent cartridge of claim 26, wherein said zirconium basic carbonate comprises  $\text{Na}^+$  of less than about 1000 ppm;

a  $\text{ZrO}_2$  wt% of from about 35 wt% to about 40 wt%;

and a  $\text{CO}_3^{2-}$  of from about 8 wt% to about 10 wt%, based on the weight of the zirconium basic carbonate.

Claim 28 (original): The sorbent cartridge of claim 27, wherein said zirconium basic carbonate has about 0 wt%  $\text{SO}_4^{2-}$  and about 0 wt%  $\text{Cl}^-$ .

Claim 29 (original): The sorbent cartridge of claim 1, wherein said sodium zirconium carbonate is present in said cartridge in an amount of from about 100 grams to about 300 grams.

Claim 30 (original): The sorbent cartridge of claim 29, wherein said cartridge further comprises zirconium phosphate in an amount of from about 300 grams to about 1900 grams.

Claim 31 (original): The sorbent cartridge of claim 30, further comprising alumina in the amount of from about 100 grams to about 500 grams, immobilized enzyme in an amount of from about 100 grams to about 300 grams, and activated carbon or other adsorbent in an amount of from about 100 grams to about 500 grams.

Claim 32 (original): The sorbent cartridge of claim 1, further comprising an immobilized enzyme material capable of enzymatic conversion of urea to ammonium carbonate, a cation exchange material in the sodium or hydrogen form, an anion exchange material in the  $\text{Ac}^-$ ,  $\text{HCO}_3^-$ ,

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Cl<sup>-</sup>, or OH<sup>-</sup> form, and an adsorbent capable of removing creatinine, uric acid, or both.

Claim 33 (original): The sorbent cartridge of claim 32, further comprising a chlorine removal material.

Claim 34 (original): The sorbent cartridge of claim 32, wherein the materials are present as two or more layers in said cartridge.

Claim 35 (original): The sorbent cartridge of claim 33, wherein the materials are present as two or more layers in said cartridge.

Claim 36 (original): The sorbent cartridge of claim 11, further comprising an immobilized enzyme material capable of enzymatic conversion of urea to ammonium carbonate, a cation exchange material in the sodium or hydrogen form, an anion exchange material in the Ac<sup>-</sup>, HCO<sub>3</sub><sup>-</sup>, Cl<sup>-</sup>, or OH<sup>-</sup> form, and an adsorbent capable of removing creatinine, uric acid, or both.

Claim 37 (original): The sorbent cartridge of claim 11, further comprising a chlorine removal material.

Claim 38 (original): The sorbent cartridge of claim 11, wherein the materials are present as two or more layers in said cartridge.

Claim 39 (canceled)

Claim 40 (withdrawn): A method to regenerate or purify spent dialysis fluid comprising passing said spent dialysis fluid through the sorbent cartridge of claim 1.

Claim 41 (canceled)

Claim 42 (withdrawn): A method to regenerate or purify spent dialysis fluid comprising passing said spent dialysis fluid through the sorbent cartridge of claim 3.

Claim 43 (withdrawn): A method to regenerate or purify spent dialysis fluid comprising

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passing said spent dialysis fluid through the sorbent cartridge of claim 4.

Claim 44 (withdrawn): A method to regenerate or purify spent dialysis fluid comprising passing said spent dialysis fluid through the sorbent cartridge of claim 5.

Claim 45 (withdrawn): A method to regenerate or purify spent dialysis fluid comprising passing said spent dialysis fluid through the sorbent cartridge of claim 6.

Claim 46 (withdrawn): A method to regenerate or purify spent dialysis fluid comprising passing said spent dialysis fluid through the sorbent cartridge of claim 11.

Claim 47 (canceled)

Claim 48 (withdrawn): A method to regenerate or purify spent dialysis fluid comprising passing said spent dialysis fluid through the sorbent cartridge of claim 13.

Claim 49 (withdrawn): A method to regenerate or purify spent dialysis fluid comprising passing said spent dialysis fluid through the sorbent cartridge of claim 16.

Claim 50 (original): An apparatus for conducting dialysis comprising the sorbent cartridge of claim 1, a dialyzer in fluid communication with said cartridge wherein spent dialysis fluid passes from said dialyzer to and through said cartridge.

Claim 51 (original): The apparatus of claim 50, wherein said spent dialysis fluid is spent hemodialysis fluid.

Claim 52 (original): The apparatus of claim 50, wherein spent dialysis fluid is restored to original balance of  $\text{Na}^+$  and  $\text{HCO}_3^-$  contents found in fresh dialysate.

Claim 53 (original): The apparatus of claim 50, wherein said dialyzer is in fluid communication with the blood of a patient.

Claim 54 (original): The apparatus of claim 53, wherein the  $\text{Na}^+$  and  $\text{HCO}_3^-$  balance in

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said blood is restored to levels found in healthy patient without renal problems.

Claim 55 (original): The apparatus of claim 50, wherein said spent dialysis fluid is spent dialysate fluid obtained from a dialyzer wherein spent peritoneal dialysis fluid is passed through said dialyzer and cleaned by fresh dialysate fluid.

Claim 56 (original): A dialysis system comprising the sorbent cartridge of claim 1 and a source of spent peritoneal dialysis solution, wherein the source of said spent peritoneal dialysis solution is in fluid communication with said cartridge wherein said spent peritoneal dialysis solution passes to and through said cartridge.

Claim 57 (original): The sorbent cartridge of claim 1, wherein said cartridge is capable of restoring the balance of  $\text{Na}^+$  and  $\text{HCO}_3^-$  in spent dialysate to levels found in fresh dialysate.

Claim 58 (original): The sorbent cartridge of claim 5, wherein said cartridge is capable of restoring the balance of  $\text{Na}^+$  and  $\text{HCO}_3^-$  in spent dialysate to levels found in fresh dialysate.

Claim 59 (original): The sorbent cartridge of claim 31, wherein said cartridge is capable of restoring the balance of  $\text{Na}^+$  and  $\text{HCO}_3^-$  in spent dialysate to levels found in fresh dialysate.

Claim 60 (new): The sorbent cartridge of claim 3, wherein said zirconium phosphate is further away from an inlet opening of said sorbent cartridge than said layer of sodium zirconium carbonate.

Claim 61 (new): The sorbent cartridge of claim 4, wherein said layer of zirconium phosphate is further away from an inlet opening of said sorbent cartridge than said layer of sodium zirconium carbonate.